PCAN-Diag

Handheld Device
for CAN Bus Diagnostics

User Manual v1.1.0

PEAK System

Products taken into account

Product Name	Model	Item Number
PCAN-Diag	High-speed CAN transceiver On request: Galvanic isolation for CAN interface Low-speed CAN transceiver Single-wire CAN transceiver	IPEH-002069

CANopen® and CiA® are registered community trade marks of CAN in Automation e.V.

All other product names mentioned in this document may be the trademarks or registered trademarks of their respective companies. They are not explicitly marked by "™" and "®".

© 2010 PEAK-System Technik GmbH

PEAK-System Technik GmbH
Otto-Roehm-Strasse 69
64293 Darmstadt
Germany

Phone: +49 (0)6151 8173-20
Fax: +49 (0)6151 8173-29

www.peak-system.com
info@peak-system.com

Document version 1.1.0 (2010-10-19)

Contents

1 Introduction 5
1.1 Properties at a Glance 5
1.2 Scope of Supply 6

2 Operation 7
2.1 CAN Connection (D-Sub) 7
2.2 Power Supply 8
2.2.1 Supply Socket 9
2.2.2 Batteries 9
2.3 Operation Using the Push Dial 11
2.3.1 Powering Up the PCAN-Diag 11
2.4 Status Display 13
2.5 Device Settings 14
2.5.1 CAN Bitrate 14
2.5.2 CAN Termination 15
2.5.3 Observation Mode (Listen-only) 15
2.5.4 Voltage Ground at the CAN Socket 15
2.5.5 Preserving Battery Sources 16
2.5.6 Screensaver 16
2.5.7 Acoustic Feedback 16

3 Managing Settings with Profiles 17

4 Receiving and Transmitting CAN Data 18
4.1 Plain View of CAN Messages 18
4.2 Symbolic View of CAN Data 19
4.2.1 Creating Symbol Definitions on the PC 19
4.2.2 Loading Symbol Definitions onto the PCAN-Diag 21
4.2.3 Opening the Symbolic View 22

4.3 Transmitting CAN Messages 23
4.3.1 Creating Transmit Lists 23
4.3.2 Using Transmit Lists 24

5 Doing Measurements on the CAN Bus 26
5.1 Bus Load 26
5.2 CAN Bus Termination 26
5.3 Voltages on the D-Sub Connector 27

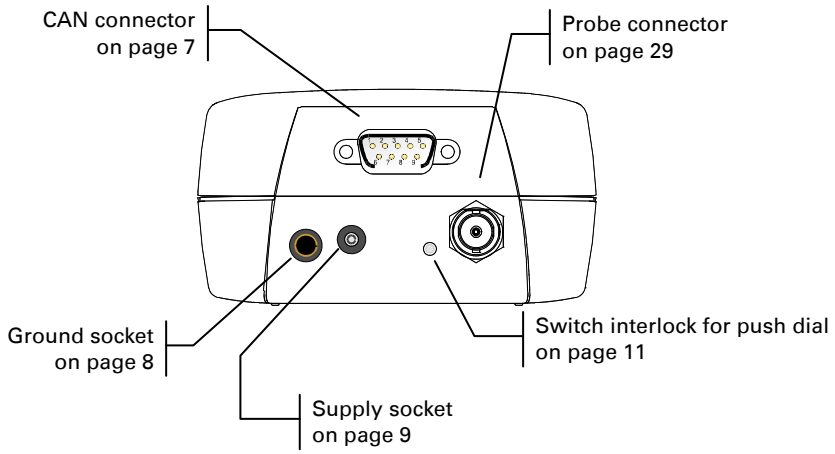
6 Scope Function 29
6.1 Using an External Measuring Signal 29

7 Technical Specifications 31

Appendix A CE Certificate 33

Appendix B Dimension Drawing 34

References for the Elements on the Back Side



1 Introduction

PCAN-Diag is a dedicated device for analysis of various aspects of a CAN bus in a mobile environment. Measurements of transmission rate, bus load, and termination resistance are possible while connected to a live bus. The device also serves as an oscilloscope which shows the differential CAN Signal with two channels and has various trigger options. A CAN frame can be decoded according to the recorded signal course. On a protocol level, messages can be displayed as a list, even in symbolic representation. In a similar way, transmit lists may be defined and submitted.

Any user input is done via a push dial.

PCAN-Diag is normally shipped with a High-speed CAN transceiver, different transceiver types may be chosen when ordering (factory equipped only).

1.1 Properties at a Glance

- High-speed CAN ISO 11898-2, transceivers for other CAN transmission standards on request
- CAN connection D-Sub 9-pin
- OLED display with 320 x 240 pixels
- Voltage supply with (rechargeable) batteries or with enclosed AC adaptor (no charging function for inserted rechargeable batteries).
- Transmission of CAN messages or message lists
- Symbolic representation of received CAN messages using CAN definition files

- Measurement of bus load
- Measurement of termination at the High-speed CAN bus (during operation)
- Voltage measurement of CAN lines
- Oscilloscope function for CAN signals with 2 channels and a sampling frequency of 20 MHz per channel
- Various triggering possibilities (CAN ID, error frame, and more)
- Decoding of CAN messages based on signal trace

1.2 Scope of Supply

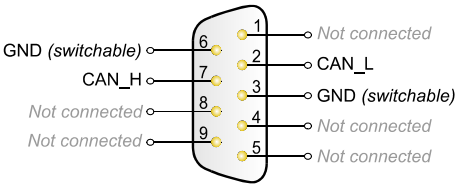
- PCAN-Diag
- Plastic case for the device and accessories
- 4 batteries 1.5 V Mignon/AA
- AC adaptor
- CD with software and documentation

2 Operation

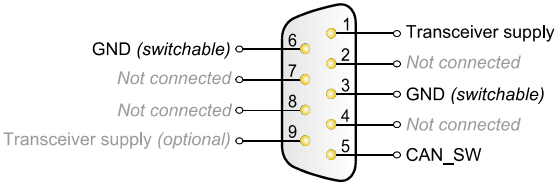
For operation of the PCAN-Diag go through the sections of this chapter in order.

2.1 CAN Connection (D-Sub)

Depending on the equipped CAN transceiver, PCAN-Diag's CAN socket (9-pin D-Sub) has different pin assignments.



Pin assignment for equipment with High-speed CAN transceiver (**standard**) or Low-speed CAN transceiver



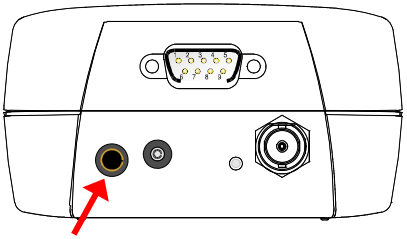
Pin assignment for equipment with Single-wire CAN transceiver (see additional notes below)

If the PCAN-Diag is equipped with a **Single-wire CAN transceiver**, an external **supply** voltage for the transceiver must be applied to **pin 1**. This voltage lies within 7 to 19 Volts, usually supplied by a car battery.

The connection of voltage ground (GND) to pins 3 and 6 can be switched via Device Settings > D-Sub GND connection. See also section 2.5.4 on page 15.

The connector's shield is internally connected to voltage ground (GND).

For separate ground connection to other CAN nodes or measuring objects an additional 4-millimeter GND socket is provided on the back of the device. The internal GND connection is permanent.



GND socket (4 mm) on the back of the device

2.2 Power Supply

The PCAN-Diag can be supplied in two ways:

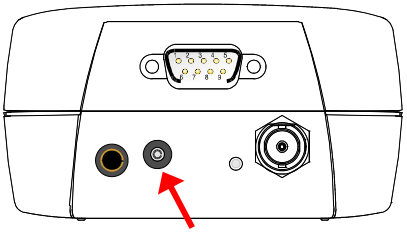
- externally via the supply socket (section 2.2.1)
- temporarily by (rechargeable) batteries (section 2.2.2)

While operation, supply status is shown on the screen's upper status bar (section 2.4).

Note: Inserted rechargeable batteries are not charged during external supply.

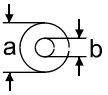
2.2.1 Supply Socket

Supplying the PCAN-Diag via the designated socket can be done using the **enclosed AC adaptor** or a **similar DC source**.



Supply socket at the back of the device
for the connection by a barrel connector

Supply voltage:
12 V DC (8 - 50 V possible)



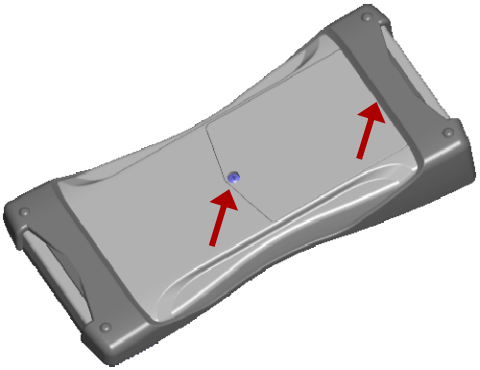
Diameter of barrel connector:
a = 5.5 mm, b = 2.1 mm;
minimum length: 11 mm

2.2.2 Batteries

For mobile use, the PCAN-Diag can be supplied by (rechargeable) batteries:

- Size: Mignon/AA
- Quantity: 4
- Single voltage: nominal 1.2 V or 1.5 V

The battery compartment is located on the device's bottom side. The lid is fixed with two screws.



Positions of the screws for the lid of the battery compartment
(second screw is located beneath the rubber sleeve)

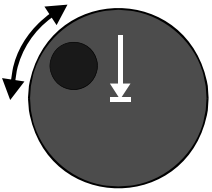
If an external supply is connected to the device, it will be used as primary source. Batteries can stay in the device.

Note: Inserted rechargeable batteries are not charged during external supply. For charging, please remove the empty rechargeable batteries and use a separate charger (not part of delivery).

2.3 Operation Using the Push Dial

Operating the PCAN-Diag is solely done by a push dial.

Dial:
Move selection; alter value

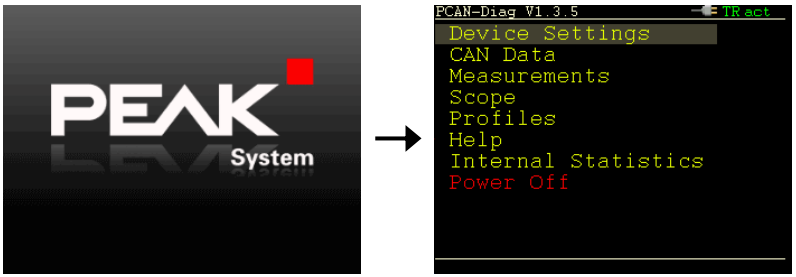


Push:
Power-up device; execute selected function; exit current function

2.3.1 Powering Up the PCAN-Diag

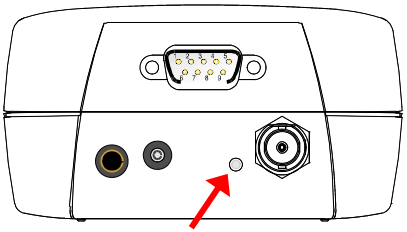
Hold down the push dial for at least half a second.

A splash screen appears for a short moment; then it's replaced by the main menu.



Turning off the device is done by selecting `Power Off` from the main menu.

Powering-up the device can be **blocked** by a small knob on the back, in order to prevent the batteries from **accidental discharging**, e.g. during transport.



Knob on the back of the device for switch interlock of the push dial

In order to activate the switch interlock, push the knob using a thin object. The device now cannot be powered-up with the push dial.

Unlocking is done likewise: push the small knob again.

2.4 Status Display

When operating the device, in the upper status bar, some symbols give information on the voltage supply status and about the CAN bus communication. Their meaning is as follows:

Symbol	Meaning
	The device is connected to an external voltage source (e.g. AC adaptor)
	The device is supplied by the inserted (rechargeable) batteries. An estimation on the remaining capacity is given.
T R	CAN traffic: T = Transmit, R = Receive Blinking: Outgoing/incoming CAN messages Green: Regular traffic Yellow, red: Erroneous traffic
act pas off	Shows information on the CAN controller's bus status register (**act**ive, **pas**sive, bus **off**). When entering bus-off state, due to high error rate, no further CAN messages are transmitted or received. In this case, after fixing the bus problem, a reset of the CAN controller should be performed, e.g. in the Receive view with Rst or the Transmit view with Reset.
L	The device operates in observation mode (listen-only). See section 2.5.3 on page 15.

2.5 Device Settings

In the main menu select Device Settings. The corresponding menu offers settings for the device which are explained in the following.

After changing any settings, make them permanent by pressing Save&OK. If you want to use the changed settings only temporarily (during the current session), press OK. A subsequent session (after an off-on cycle) uses the initial settings again.

Tip: Using Profiles from the main menu, you can save different sets of device settings (profiles) and recall them later on demand. See also chapter 3 on page 17.

2.5.1 CAN Bitrate

When connecting PCAN-Diag to an “unknown” CAN bus, transmission speed may be detected **automatically** using menu item Detect CAN bitrate. This feature assumes some CAN traffic on that bus.

The **manual selection** is done with CAN bitrate. Here you can select from a list of predefined bit rates.

To adapt to **specific conditions**, experts may directly access the CAN controller's bus timing registers BTR0 and BTR1. To do so, set the item CAN bitrate to User and under User CAN bitrate (hex) enter a 2-byte value (4 hex digits) being written to the registers.

Note: CAN decoding as part of the scope function doesn't work with user defined CAN bitrates.

Get further information about setting the CAN bitrate by Bus Timing Register on request (contact data: see on page 2).

2.5.2 CAN Termination

A High-speed CAN bus needs to be electrically terminated on both ends using resistors of 120 Ω. If the PCAN-Diag is connected to an un-terminated end of a CAN bus, you can activate an internal resistor by menu item `CAN termination`.

Note: This menu item is only available if the device is equipped with a High-speed CAN transceiver.

- `Off`: Termination is already correctly applied to the High-speed CAN bus and the device is connected to a tap within the CAN bus.
- `On`: The device is connected to a CAN bus whose termination isn't complete yet.

Tip: If you want to check that a connected High-speed CAN bus is terminated correctly, you can use the function `Measurements` > `CAN Termination` (see also section 5.2 on page 26).

2.5.3 Observation Mode (Listen-only)

If the device shall silently watch traffic on the CAN bus without influencing it, you can activate the `Listen-only mode` (set to `On`). Doing so, the device will neither acknowledge nor transmit CAN (error) frames.

2.5.4 Voltage Ground at the CAN Socket

Connecting the device's voltage ground to the monitored CAN bus may not be useful in some cases. On the scope function differing ground levels may cause improper readings, for example.

Therefore, you can disconnect the device's voltage ground from D-Sub connector by software. To do so, set the menu entry `D-Sub GND connection` to `Off`. This setting is relevant for pins 3 and 6 of the D-Sub connector together (for assignment overview see on page 7). The connector shield is permanently connected to the device's voltage ground.

2.5.5 Preserving Battery Sources

If you run the PCAN-Diag with (rechargeable) batteries, battery sources can be preserved by switching off the device automatically after a set period of inactivity. You may determine the period with `Shutdown time (battery)`. Setting to `Never` causes the device to be alive all the time.

If operating the device with an external supply, for example with the enclosed AC adaptor, this setting doesn't have any effect.

2.5.6 Screensaver

The brightness of the display will be reduced whenever the device is not operated for a certain period. You can set this period with `Screensaver timeout`.

2.5.7 Acoustic Feedback

The PCAN-Diag can give acoustic feedback to several events. This function is enabled or disabled with `Beeper`.

3 Managing Settings with Profiles

In order to quickly adapt the PCAN-Diag to another operational environment, settings can be reloaded from a profile that has been saved before. The PCAN-Diag offers five storage locations.

The following settings are included in the profiles:

- device settings
- measurement settings for the D-Sub connection
- scope settings

The management is done via the item `Profiles` in the main menu. Profiles are stored in the device's internal memory.

Note: Symbol definitions for CAN data are managed independently of the settings profiles. See also section 4.2 *Symbolic View of CAN Data* on page 19.

4 Receiving and Transmitting CAN Data

The PCAN-Diag displays all CAN messages on a connected CAN bus and transmits user defined CAN messages as well. Representation of message content is either in hexadecimal format or symbolic. Symbol definitions are transferred via the connected CAN bus.

4.1 Plain View of CAN Messages

You can access the plain view of incoming CAN messages via `CAN Data` > `Receive Messages`. Representation of CAN data is in hexadecimal format.

Incoming CAN messages are displayed as a list, sorted by CAN ID. You can **manipulate sorting** by clicking on CAN messages. Those get priority then, meaning that they are shifted to the top of the list. Messages with priority are displayed in **orange** color. Clicking on orange CAN messages takes back priority, meaning that they are sorted by CAN ID again.

Further functions:

Function	Explanation
`Rst`	Clears the list of incoming CAN messages and resets the CAN controller. This might be useful in case of CAN errors.
`Tx1` ... `Tx7`	Activates the selected transmit list. The bottom status bar gives information to the selected transmit list. Transmit lists are managed in `CAN Data` > `Manage Transmit Lists`.

4.2 Symbolic View of CAN Data

For displaying data of incoming CAN messages in symbolic representation, a symbol file must be created on PC and uploaded via CAN to the PCAN-Diag then.

Preconditions for applying symbol definitions to the PCAN-Diag are:

- Computer with CAN interface of the PCAN series (e.g. PCAN-USB)
- CAN cabling with correct termination
- Windows 7/Vista/XP (32/64-bit)
- PPCAN-Editor for Windows (setup file is provided on the enclosed CD) incl. hardware profile for PCAN-Diag

4.2.1 Creating Symbol Definitions on the PC

Symbol definitions are created with the PPCAN-Editor as a so-called configuration. Necessary steps for doing so are explained by an example with following properties:

Property	Value
CAN ID (hex)	300
Symbol name	DemoMessage
Data length (DLC)	2 bytes
Data (variables)	Meter (8 bits) Switch1 (1 bit) Switch2 (1 bit)

Do the following to create a configuration with symbol definitions in the PPCAN-Editor:

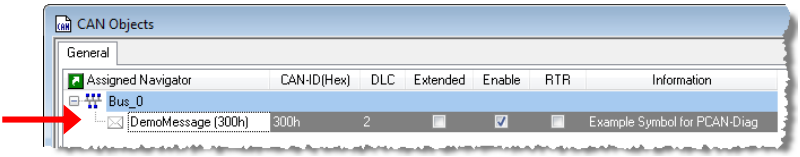
1. Select the menu entry **File** > **New** (alternative:).

   The window CAN Objects appears with the General tab.

2. On the **General** tab select the entry **Bus_0** and then the menu item **CAN Objects** > **Add a new Symbol** (alternative:).

   The new entry Symbol1 appears in the tree structure.

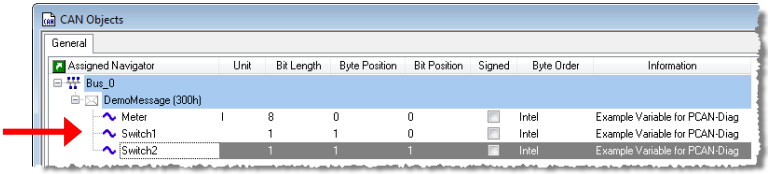
3. Modify the entry by clicking each single field and enter the example's values. Make sure to enable the entry (**Enable** is checked).



4. Select the menu item **CAN Objects** > **Add a new Variable** (alternative:).

5. Adjust the entry **Var1** (variable Meter).

6. Repeat the last two steps for the other variables.



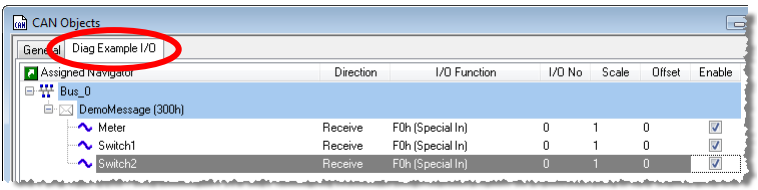
7. Select the menu item **Edit** > **New Configuration** (alternative:), and then, from the opened list the item **$1A: PCAN-Diag**. Confirm your selection with **OK**.

   The CAN Objects window gets the additional tabConfig0 I/O.

8. Click the tab **Config I/O** and enter a name for it (e.g. Diag Example).

9. From the **General** tab select the entry **Bus_0**, then select the menu item **CAN Objects** > **Add Bus to Configuration**, and subsequently from the displayed list select the entry **Diag Example I/O**. Confirm your selection with **OK**.

10. On the tab **Diag Example I/O** enable the symbol **DemoMessage** and each variable by checking the boxes in the column **Enable**.



Note: The properties for symbol and variable entries are available, if an entry of the corresponding category is selected.

11. Optionally: Use **File** > **Save** (alternative:) to retain the configuration for later use on a data carrier.

4.2.2 Loading Symbol Definitions onto the PCAN-Diag

Symbol definitions are loaded onto the PCAN-Diag via CAN bus. To do so, on the PC side the PPCAN-Editor is used, the same tool as used to define a configuration with symbol definitions before.

Do the following to load the symbol definitions onto the PCAN-Diag:

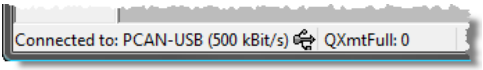
1. On the PCAN-Diag select `CAN Data` > `Manage Symbol Files`.

   Three list entries are displayed to be loaded with symbol definitions.

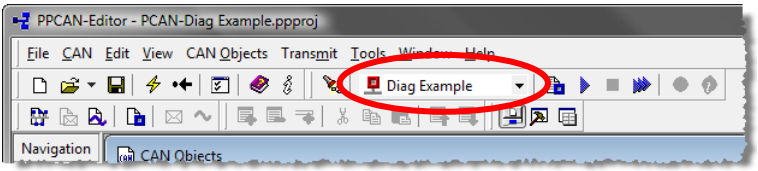
2. For one of those three list entries click on `Load` which initiates transmission via CAN.

   The PCAN-Diag now awaits configuration data from the PC.

3. In PPCAN Editor, ensure to be connected to the appropriate CAN bus (see bottom status bar, left corner; the figure shows an example).



4. On the toolbar select the configuration **Diag Example** from the dropdown list.



5. Select the menu item **Transmit** > **Send Configuration** (alternative:).

   The transfer starts and takes a few seconds. The PCAN-Diag's display shows “Receiving configuration”.

6. When the transfer is finished, confirm with OK on the PCAN-Diag.

   The previously selected list entry now contains the symbol definition Diag Example.

7. Activate that list entry by checking the blue box, thus applying the symbol definition to the reception list.

4.2.3 Opening the Symbolic View

For displaying CAN data in a symbolic representation, differing from the plain view a separate one is used, that you can open with CAN Data > Receive Msgs. as Symbols. As a precondition, symbol definitions must be loaded and activated, as explained above.

4.3 Transmitting CAN Messages

PCAN-Diag allows creating up to 15 transmit lists with one or more CAN messages. Transmit lists may be processed either cyclically or once on request. CAN messages within the same list may have an individual time offset to each other.

4.3.1 Creating Transmit Lists

Do the following to create one or more transmit lists:

1. Select `CAN Data` > `Manage Transmit Lists`.

   You'll see an overview of the available transmit lists.

2. Activate an entry below `Transmit list` by checking the corresponding box.

   A checked entry is marked with a cross `[X]`. This means, that this list is available for transmission and its properties can be modified.

3. Click on the list entry's name in order to edit the properties. If the entry hasn't been used yet, the name is `unused`.

   An edit view is shown.

4. Modify the list's name by clicking on it.

5. By default, the list already contains one entry. With the mnemonics `EID` on the right you can do following actions:

Mnemonic	Action	Explanation
E	Edit	Shows a CAN message's properties to be modified.
I	Insert	Adds a new CAN message to the list at the given position. Content is taken from the current CAN message.
D	Delete	Removes this CAN message from the transmit list.

While editing a CAN message, in addition to the common properties the entry Offset is available. It determines the delay in milliseconds after which the CAN message is transmitted. The offset refers to the previously transmitted CAN message, thus this is a relative designation.

6. Note the given value for Min. required cycle time below the transmit list. This is the lowest cycle time to be used for the transmit list.

   You'll set the cycle time for a transmit list later in the overview of all transmit lists.

7. Confirm your modifications to the transmit list with OK.

8. Set the Cycle time for each transmit list in the corresponding column. The value 0 ms means that the transmit list is only initiated manually.

Note: A cycle time less than the required minimum will cause transmission of an incomplete list. The rearmost messages are never transmitted.

9. After creating and enabling transmit lists, scroll down and confirm your work with OK.

4.3.2 Using Transmit Lists

Do the following to transmit the CAN messages contained in a transmit list:

1. Select CAN Data > Transmit Messages.

   This shows all available transmit lists.

2. Activate a transmit list by clicking on it.

A list with a defined cycle time will be displayed in orange color. It is processed until deactivated by another click on it or by power cycling the PCAN-Diag.

A transmit list without cycle time is only processed once. It is always displayed in orange color.

Tip: You can also activate transmit lists from the plain reception view (`CAN Data` > `Receive Messages`), where the first seven transmit lists (`Tx1` to `Tx7`) are available.

5 Doing Measurements on the CAN Bus

5.1 Bus Load

Accessible via: Measurements > Bus Load

The percentage utilization of the CAN bus with CAN messages is shown in a graph over a period of time and is continuously updated.

The graph is put together out of sampling intervals whose duration results from the set CAN bitrate and the given number of Samples.

Per sample value an average and a maximum value of the bus load are calculated and shown as bars.

You can counter a high bus load by

- raising the bitrate of all involved CAN nodes, or
- increasing the cycle time of ascertained CAN messages in the CAN net in order to reduce emergence (less CAN messages per time).

5.2 CAN Bus Termination

Accessible via: Measurements > CAN Termination

Note: This function is only available, if the PCAN-Diag is equipped with a High-speed CAN transceiver.

A High-speed CAN bus (ISO 11898-2) must be terminated with 120 Ω on both ends between the CAN lines CAN_L and CAN_H. This

measure will prevent signal reflections at the cable ends and a correct function of CAN transceivers attached to the CAN bus is assured.

The two termination resistors in parallel result in a total resistance of 60 Ω. The measurement of the total resistance provides information about a correct CAN bus termination.

Measurement	Interpretation
~ 60 Ω	The termination at the CAN bus is ok in terms of measurement. Make sure that the termination resistors are positioned at each end of the bus and not, for example, at taps in the middle of the bus.
~ 120 Ω	Only one termination resistor is present. Install a further 120-Ohms resistor at the opposite bus end.
< 45 Ω	Too many termination resistors are present at the CAN bus. A reason may be that on one bus end both a separate termination resistor as well as a CAN node with internal termination are installed.

5.3 Voltages on the D-Sub Connector

Accessible via: `Measurements` > `D-Sub Connector`

The voltages for each pin of the D-Sub connector can be viewed for a rough assessment.

Note: Because of a delay at voltage measurement due to technical reasons, transient voltage fluctuations cannot be detected.

You can configure the display for each pin (`Settings`):

- Pin `Name`
- Voltage display on/off (`Enable`)

- Range for valid voltages per pin (Min/Max). This range is only for display and doesn't have a functional background (beside alarm).
- Generation of an Alarm, if the measured voltage leaves the given range (not at voltage spikes). The device setting for alarms (Beeper) must be activated.

6 Scope Function

The PCAN-Diag can show the waveform of the CAN lines CAN_L and CAN_H, or of the CAN line CAN_SW. Handling the scope function is similar to a standard storage scope.

Additional auxiliary functions are available in order to facilitate the interpretation of a signal:

- Triggering to CAN frames
- Measuring of a period with cursors
- Decoding of the waveform

You can access the scope function via the main menu entry Scope.

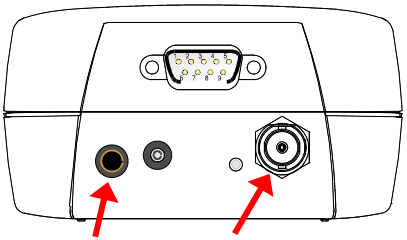
6.1 Using an External Measuring Signal

The second channel of the scope function can sample an external signal for measuring and trigger purposes instead of the CAN_L signal. This is routed from the BNC connector on the back of the device.

For an external measuring signal a probe is needed, which is not included. Suitable is a standard probe without additional electronics, which is operated with setting x1.

The voltage of an external measuring signal may have a **maximum of ±50 V**.

In order to establish a separate voltage ground connection between the PCAN-Diag and the measuring object, a ground socket (4 mm) is provided.



Ground socket and BNC connector for probe
on the back of the device

To link the second scope channel to the external measuring signal do the following setting:

Scope > Settings > Ch2 source

Setting	Measuring range
Probe (low)	-3 - +15 V
Probe (high)	-10 - +50 V

7 Technical Specifications

Power supply	
Supply voltage	Externally via supply socket: 12 V DC nominal, 8 - 50 V possible Internally with 4 (rechargeable) batteries (size Mignon/AA): 4 x 1.5 V or 4 x 1.2 V DC **Note:** The device doesn't charge inserted rechargeable batteries.
Power consumption	External supply: 8 V (min.): 300 mA 12 V (nom.): 200 mA 32 V: 83 mA 50 V (max.): 50 mA Operation with batteries: 5 V: 300 mA
Single-wire CAN transceiver (optional)	7 - 19 V DC via D-Sub connector pin 1 (optionally pin 9)

CAN	
Standard transceiver	High-speed CAN ISO 11898-2 (PCA82C251)
Other transceivers (on request)	Low-speed CAN ISO 11898-3 (TJA1054) Single-wire CAN SAE J2411 (TH8056/AU5790)
Termination	High-speed CAN (ISO 11898-2): 120 Ω switchable via software Low-speed CAN (ISO 11898-3): none Single-wire CAN (SAE J2411): none
Galvanic isolation	On request (only with High-speed CAN transceiver)

Display	
Type	OLED
Resolution	320 x 240 pixels

Measures	
Size	103 x 58 x 212 (225 with BNC connector) mm (W x H x L) See also dimension drawing Appendix B on page 34
Weight	400 g (14.1 oz.) (without batteries)

Environment	
Operating temperature	-20 - +60 °C (-4 - +140 °F)
Temperature for storage and transport	-40 - +80 °C (-40 - +176 °F)
Relative humidity	15% - 90%, not condensing
EMC	EN 61326-1:2006-10 EC directive 2004/108/EG EN 55011
Ingress protection (IEC 60529)	IP20

Appendix A CE Certificate

PCAN-Diag IPEH-002069 – EC Declaration of Conformity
PEAK-System Technik GmbH

Notes on the CE Symbol CE

The following applies to the PCAN-Diag product IPEH-002069

EC Directive

This product fulfills the requirements of EC directive 2004/108/EG on "Electromagnetic Compatibility" and is designed for the following fields of application as per the CE marking:

Electromagnetic Immunity/Emission
DIN EN 61326-1; publication date: 2006-10
Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements (IEC 61326-1:2005);

German version EN 61326-1:2006

Declarations of Conformity

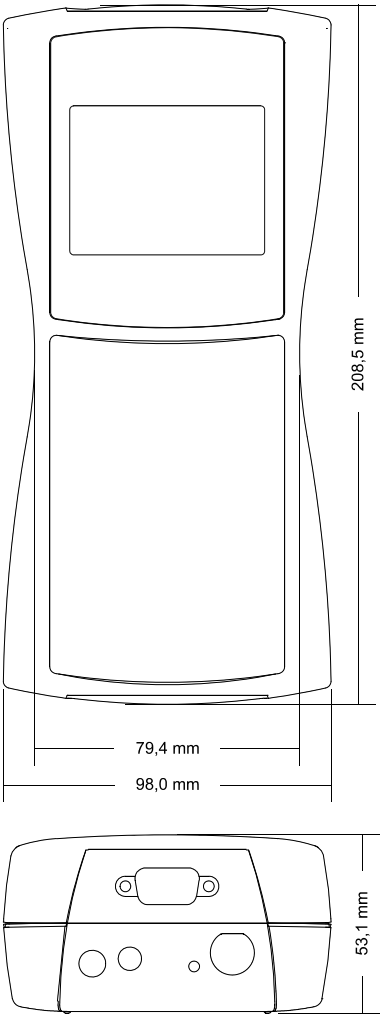
In accordance with the above mentioned EU directives, the EC declarations of conformity and the associated documentation are held at the disposal of the competent authorities at the address below:

PEAK-System Technik GmbH
Mr. Wilhelm
Otto-Roehm-Strasse 69
64293 Darmstadt
Germany

Phone: +49 (0)6151 8173-20
Fax: +49 (0)6151 8173-29
info@peak-system.com

Signed this 25th day of June 2010

Appendix B Dimension Drawing



The figure doesn't show the original size;
dimensions for case without rubber sleeve